Viscoelasticity-based Staging of Hepatic Fibrosis with Multifrequency MR Elastography[1]

Patrick Asbach, MD
Dieter Klatt, PhD
Beate Schlosser, MD
Michael Biermer, MD
Marion Muche, MD
Anja Rieger, MD
Christoph Loddenkemper, MD
Rajan Somasundaram, MD
Thomas Berg, MD
Bernd Hamm, MD
Juergen Braun, PhD
Ingolf Sack, PhD

Purpose: To analyze the dynamics of the shear modulus of the liver to assess the optimal driving frequency and to determine the diagnostic accuracy of generalized frequency-independent elasticity cutoff values for staging hepatic fibrosis.

Materials and Methods: This institutional review board–approved prospective study included 16 healthy volunteers and 72 patients with biopsy-proved liver fibrosis. After obtaining written informed consent, imaging was performed at 1.5-T by using a motion-sensitized echo-planar imaging sequence. Wave excitation was performed by an actuator introducing a superposition of four frequencies (25.0, 37.5, 50.0, 62.5 Hz) of shear waves. The elasticity μ value and the structure geometry parameter α were calculated by using the two-parameter springpot model. The performance of magnetic resonance (MR) elastography in staging liver fibrosis was assessed with area under the receiver operating characteristic curve (AUROC) analysis and Spearman correlation analysis.

Results: Elasticity increased with stage of fibrosis, with mean values as follows: for volunteers, 2.25 kPa ± 0.43 (standard deviation); stage F1, 2.61 kPa ± 0.43; stage F2, 3.00 kPa ± 0.63; stage F3, 3.86 kPa ± 0.61; and stage F4, 5.86 kPa ± 1.22. Frequency-independent cutoff values derived for fibrosis and AUROC values, respectively, were as follows: stage F1 or higher, 2.84 kPa and 0.9128; stage F2 or higher, 3.18 kPa and 0.9244; stage F3 or higher, 3.32 kPa and 0.9744; and equivalent to stage F4, 4.21 kPa and 0.9931. The geometry of the tissue (α value) did not correlate with fibrosis. Frequencies of 50.0 Hz and 62.5 Hz displayed the highest diagnostic accuracy.

Conclusion: The diagnostic performance of multifrequency MR elastography in determining the degree of hepatic fibrosis increases with stage of fibrosis. Metrics obtained at the higher frequencies provide better diagnostic performance compared with the lower frequencies. Results of the AUROC analysis demonstrate the high accuracy of frequency-independent cutoff values for staging higher grades of hepatic fibrosis.

[1] From the Department of Radiology, Charité–Universitätsmedizin Berlin, Charitéplatz 1, 10117 Berlin, Germany. From the 2009 RSNA Annual Meeting. Received December 31, 2009; revision requested February 8, 2010; final revision received March 2; accepted March 20; final version accepted April 5. Supported by the German Research Foundation (grant Sa/901-3). **Address correspondence to** P.A. (e-mail: *patrick.asbach@charite.de*).